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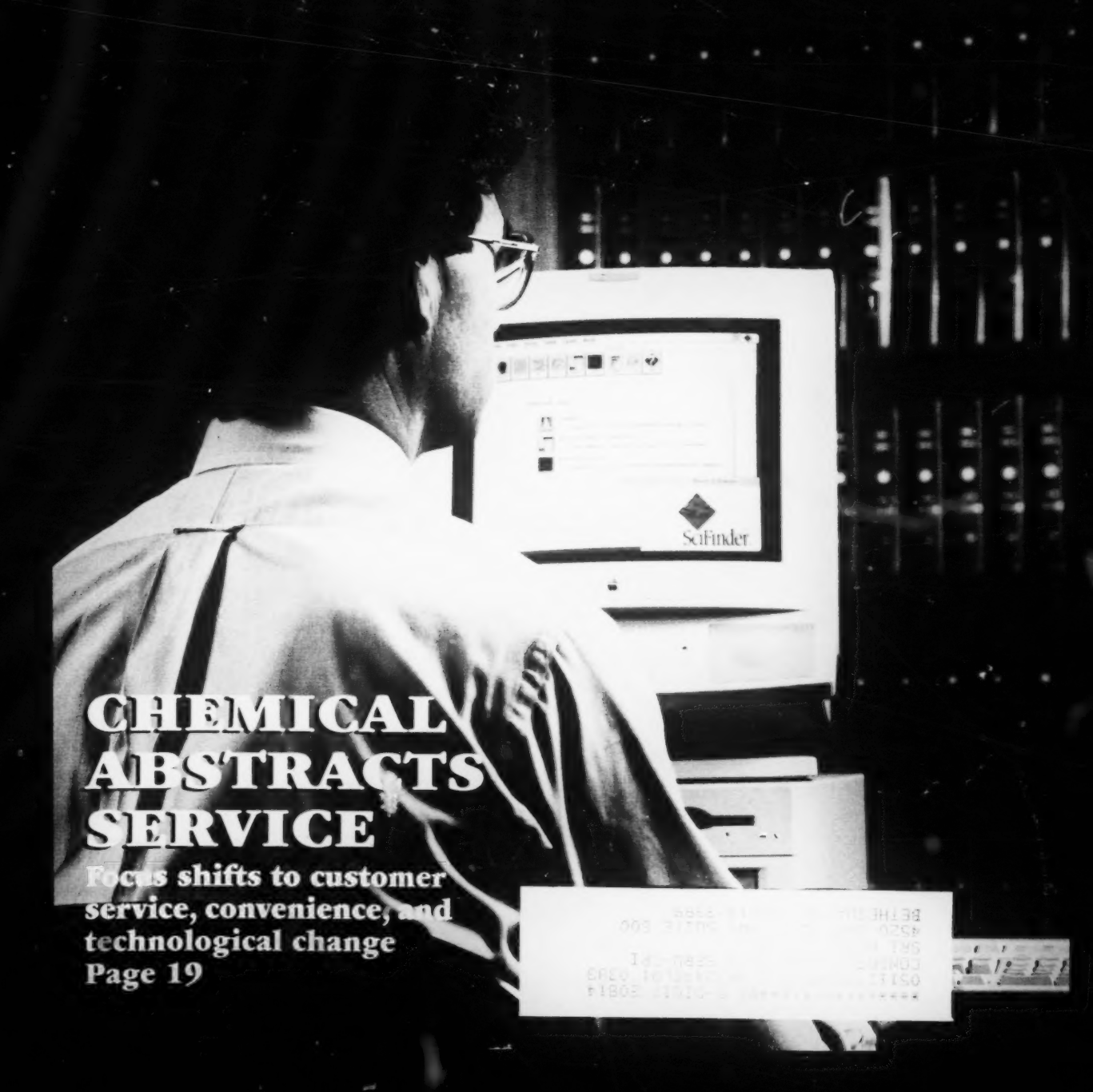
CHEMICAL & ENGINEERING NEWS

C&EN

OCTOBER 31, 1994

ETHYLENE GLYCOL PRODUCERS STRUGGLE TO MEET SOARING DEMAND PAGE 8




# CHEMICAL ABSTRACTS SERVICE

**Focus shifts to customer service, convenience, and technological change**
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CHEMICAL & ENGINEERING NEWS

C&EN

OCTOBER 31, 1994

## NEWS OF THE WEEK

■ Floods in the Houston area rupture pipelines and shut down chemical plants and transportation routes, further vexing already tight petrochemical markets. **Page 3**

■ Shell Chemical, DuPont, and Hoechst Celanese reach tentative agreement to reimburse homeowners at least $750 million to settle polybutylene pipe suit. **Page 4**

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■ Carnegie Mellon chemists synthesize a "molecular photonic wire" that absorbs a photon of light at one end and emits a different photon at the other end. **Page 5**

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# LETTERS

## Exceeding Earth's capacity

The ideas of Bryan J. Cook (C&EN, May 16, page 5) and Frank A. Anderson (C&EN, June 13, page 4) deserve elaboration, particularly one social dilemma created by the continuing application of science-backed technology. I refer to the decrease in the carrying capacity of planet Earth for people that occurs each time there is an increase in human technological activity. This interconnectedness has long been unrecognized or ignored. I regret that my 40-year career in chemical science and technology produced a number of conventional economic evaluation studies in which this carrying capacity factor was never recognized by the existing myopic economic system. The negative social impact, veiled from my view then, is clear to me now.

Carrying capacity could be ignored if it were larger than the current global population size. Unfortunately, it is smaller. Numerous scholars now insist that population exceeds carrying capacity. My own studies, based on waste disposal capabilities, suggest that population currently exceeds carrying capacity by a factor of between 10 and 40. It is this excess that drives the social changes Cook attributes to science. The larger that excess becomes, the more rapid are the changes. While technology has certainly decreased carrying capacity in years past and continues to do so in the present, responsibility for the exploding population, the numerator in the ratio, belongs elsewhere.

As the demand for sustainability increases, the chemical industry will need to come to terms with this scenario and with the industrial contribution to the denominator in this ratio.

**Carlyle Herrick**
*Alplaus, N.Y.*

## Transfermium wars

Concerned readers should not overreact to the news of the recommendations by the International Union of Pure & Applied Chemistry's (IUPAC) Commission on Nomenclature of Inorganic Chemistry (CNIC) concerning new names for the transfermium elements (C&EN, Oct. 10, page 4). Their unwise suggestions have no procedural power of enforcement behind them. I state that without any authority, in parallel with CNIC's lack of authority to impose the naming sequence for elements 104–109. All that has been done with this strange idea and imprudent treatment of the uncontested discoverers of seaborgium is to embarrass IUPAC.

For more than a decade, IUPAC has been incapable of resolving the conflict of discovery of elements 104 and 105 to the satisfaction of the interested chemical community. They participated in a flawed study to settle the dispute and issued a recommendation in late 1992 that was received with critical disclaim. IUPAC did not place heavy-element nuclear chemistry experts on the study panel (the transfermium working group) as they were charged to do, nor did they conduct their investigation in an iterative protocol, as they were charged to do, and which would seem logical and necessary. They did permit the Russian contestants for element 104 to do a total about-face following an unprecedented reanalysis of old data, and to contradict the Russians' own original firm conclusions about what they had done. The transfermium working group's judgment was arguably motivated by a fervent desire to do everything possible to coerce a compromise. Nevertheless, there was no dispute over element 106.

Because of the controversy surrounding the way in which the transfermium working group focused their labors, a movement was started to try to prevent any formal recommendations from being made until the review panel completed their investigation properly so that the endorsement on discovery claims at least had the appearance of being merited by the facts. This was not forthcoming.

The ACS Committee on Nomenclature then officially adopted the following names for use in the U.S. and forwarded these as a recommendation to IUPAC: 104 = rutherfordium, 105 = hahnium, 107 = nielsbohrium, 108 = hassium, and 109 = meitnerium. (Attention textbook publishers, these are the names that will be used in the U.S.) The latter three elements had been justifiably credited for the most part to German researchers, and those names are the ones they had suggested.

Element 106 was not included because its discovery had not yet been confirmed by independent means. This verification was recently attained. The original discoverer proposed the name seaborgium at the

*Continued on page 32*

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supply of purified terephthalic acid (PTA), a key raw material in the production of polyester, will serve as a limiting factor in demand for fiber-grade ethylene glycol in 1995. "However, in 1996, hang on to your hat," he says. "Lots of PTA capacity will be coming on stream, opening the floodgates of polyester production and creating a potential shortage of glycol."

Recognizing this trend, at least two producers are gearing up for capacity expansions in that time frame. Occidental Chemical is evaluating significant expansions at its Bayport and Beaumont, Tex., facilities to be on line within two to three years. More significantly, Union Carbide is teaming up with Petrochemical Industries Co. of Kuwait in a joint venture to build and operate a petrochemicals complex in Kuwait that will include a 770 million-lb-per-year ethylene glycol plant. Like the Red Deer plant in Canada, this facility will have an advantageous feedstock position and will be well positioned to serve the Asia-Pacific region.

Still, Rightler predicts that these expansions "may not be large enough to meet demand." Fortuitously, Carbide's forecast paints the same picture. "By the time we get to 1996, especially late 1996, we think the ethylene glycol market will again be tight. In fact, we may wish that the Kuwait plant came on earlier than scheduled." □

## Europe looks to 'new perspectives' in polymers

"Profiting from new perspectives" was the theme for the annual meeting of ECMRA, the business research and planning association in Europe, earlier this month in Leipzig, Germany. The theme foretold what has become clear as the year draws to a close: business is picking up, and now is the time for concentrating on what's new, rather than gloomy rehashings of such matters as overcapacity and low profitability.

High on the agenda were new technologies for making polyethylene and environmental concerns for the industry—including an encouraging look at second-generation biopolymers.

According to David Oxley, a director at the London office of consultants ChemSystems, global demand for polyethylene of all types now amounts to about 37 million metric tons per year. Of that amount, about 15 million metric tons each is accounted for by low-density polyethylene (LDPE), made at high pressure, and high-density polyethylene (HDPE), made at relatively low pressure. Linear low-density polyethylene (LLDPE), also made at relatively low pressure, makes up the remaining 7 million metric tons per year.

However, the global market for LLDPE is expected to reach 12 million metric tons by 2000. Demand for LDPE will rise only modestly—to about 17 million metric tons—as it faces competition from LLDPE, which has gained market share through lower prices. HDPE, on the other hand, will continue to experience solid growth to 19 million metric tons per year by 2000.

In addition, changing technology for making polyethylenes will have a significant impact on the industry, says Oxley.

Among the new processes for making or modifying polyethylenes, Oxley says, are:

- Metallocene catalysts, which enable a producer to "tailor a polyethylene molecule more accurately. That is true for polyethylene or polypropylene but is particularly important for LLDPE."
- Bimodal/broad molecular weight LLDPEs, which are easier to process than earlier LLDPEs. Because LLDPE is more difficult to process than LDPE, producers of LLDPE have had to accept lower prices to build market share. Now they will be able to justify asking for the same price for LLDPE as for LDPE.
- Superhexene LLDPE, which features new comonomers for improved performance. Although very costly now, prices are expected to come down as South Africa's Sasol and Czech producers become serious suppliers of comonomer α-olefins.

On metallocene catalysts alone, more than 350 patents were issued or were pending by the beginning of this year, Oxley says. High on the list, with about 80 patents, was Mitsui Toatsu Chemicals; with about 50 patents each were Hoechst, Mitsui Petrochemical, and Exxon; at about 20 each were BASF, Fina, Idemitsu, and Mitsubishi Petrochemical. Dow Chemical, Showa Denko, Phillips, British Petroleum, Chisso, and Mobil all had about 10 patents each; and Tosoh held fewer than 10. Curiously, Union Carbide and Himont—major players in the polyethylene and polypropylene fields—had none.

Oxley predicts that by 2010, the demand for metallocene-produced polyethylene will be 2.5 million metric tons per year. Bimodal/broad molecular weight LLDPE will find much larger demand—about 3.3 million metric tons per year. He expects Europe to dominate in this sector. Polyethylenes containing higher α-olefin comonomers (for example, 1-octene) will have demand of about 1.2 million metric tons per year.

"The new developments in catalysts allow much simpler plants to make the sophisticated polymers, and this will cut the cost and widen the supply base. Whether this is a good thing for corporate profitability remains to be seen," he adds.

For one thing, companies have invested a great deal of money in their research—money that ultimately will have to be recouped. For example, according to ChemSystems' estimates, from 1983 to 1993, some $2 billion has been spent on R&D for second-generation polyethylenes, half of that on metallocene research alone. Moreover, more than $1 billion in new capital expenditures has been approved since the beginning of 1993 for second-generation polyethylenes. "All this [expense] has to be paid for by licensing or by profit margins," he notes.

On a much more modest basis, a second generation of biodegradable polymers is being developed, says Luigi Marini, business manager for these materials at Italy's Novamont, a sister company of Montecatini. Applications vary for the polymers, which are available as films, fibers, and foams.

More than a dozen companies are active in the field, with products at various

### German recycling fees are highest for plastics

| | $ per kg |
|---|---|
| Plastics | $1.97 |
| Composites | 1.40 |
| Beverage cartons | 1.13 |
| Aluminum | 1.00 |
| Tinplate | 0.37 |
| Paper | 0.33 |
| Natural materials | 0.13 |
| Glass | 0.10 |

Source: Duales System Deutschland

stages of commercial development. For example, in the field of starch-polyester polymers, Novamont has capacity of 4,000 metric tons per year; Chisso, in Japan, has a plant under construction; and in the U.S., National Starch and Enpac have operations of undisclosed capacity. Ems-Chemie, Melitta, and Biopack—all European companies—are in the pilot-plant stage with their starch-based polymers.

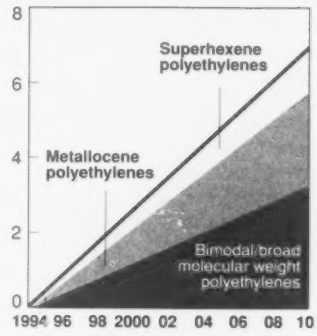
The synthetic polymer side is somewhat more advanced. Union Carbide in the U.S. and Daicel in Japan both have capacities of at least 4,000 metric tons per year of polycaprolactone. Cargill in the U.S. has capacity of 4,500 metric tons per year of polylactic acid. The U.K.'s Zeneca can make up to 600 metric tons per year of its polyhydroxy butyrate-valerate, and Japan's Showa Denko has more than 1,000 metric tons per year of capacity for its polymer made of butanediol and succinic acid.

The important point about these materials, contends Marini, is that biodegradable materials "must be seen in competition with materials like cardboard, paper, glass, and wood—not with other polymers. There are different requirements" as the polymers vie for markets in packaging or in consumer goods that would otherwise wind up in landfills. The largest proportion of waste goes to landfills—some 60%, he says, with another 30% incinerated and 10% recycled. A goal of the European Union (EU) is to reverse this situation by the end of the decade, to 10% for landfills, 35% for incineration with energy recovery, and 55% for recycling and composting.

Biodegradable polymers cannot compete directly with traditional polymers, but they can give a cost-effective solution to waste—a point even the environmental movement has begun to recognize, he suggests. "The "green" movement has been very much against the early generation of starch-polyethylene materials—and they were absolutely right. These materials do not biodegrade," Marini says. "They don't solve any problems."

Where composting is not feasible, recycling is becoming more and more important for European society. According to Edelgard Bially, a group leader with Duales System Deutschland (DSD), the organization responsible for recycling postconsumer packaging wastes in Germany, the average European citizen piles up about 770 lb of waste each year. Of that, packaging waste makes up 30% by weight and 50% by volume, one reason why packaging has become a priority target among German environmental officials.

**Demand to rise most for bimodal polyethylenes**



Source: ChemSystems

In June 1991, a German federal ordinance decreed that packaging material must be recycled: 50% of glass, tinplate, aluminum, paper and cardboard, composites, and plastics, each year until July 1995. From July 1995, the proportion that must be recycled rises to a minimum of 80%, Bially explains.

DSD runs its system on a cost-covering basis, with financing through license fees for use of its trademarked Green Dot on packaging that can be recycled. The license fee is paid by the product packager. At the beginning of October, DSD's licensing fee structure was changed to include volume as a pricing factor, in addition to weight and the material involved. The fee for glass packaging was dropped slightly—as was that for plastics, which fell from 3 deutsche marks (about $2.00) per kg to 2.95 deutsche marks per kg of waste packaging; the fee for plastics, however, remains the highest of all the packaging materials.

As Bially puts it, "Every system depends on the efforts of its participants," and German consumers have taken the concept of recycling to heart. In 1993, some 4.6 million metric tons of recyclable material were collected, 57% of the potential. Out of the amount collected, 3.9 million metric tons were sorted for recycling. In 1993, 15% less waste than in 1991 had to be disposed of, she says.

And despite the "villain" environmental image of plastic packaging, Bially notes that it actually provides one of DSD's major recycling successes. There have been at least two reasons: the controversial exports to other countries for recycling and the development and adoption of feedstock recycling—the thermal cracking of polymers back into reusable feedstocks.

Germany now has one commercial feedstock recycling operation, run by Veba Oil and Ruhrkohl Umwelt, with capacity of up to 50,000 metric tons per year, and scheduled for expansion to 140,000 metric tons next year. BASF has piloted a scheme with 15,000 metric tons per year of capacity, and it plans to have capacity of 200,000 to 300,000 metric tons as of 1996. That, Bially argues, is extraordinary, considering that when the ordinance was put into effect in 1991, "nobody was talking about feedstock recycling at all." Now, however, "if all the offered capacity comes on stream," says Bially, "we might even come into the situation that we could import waste plastics into Germany."

On the same day ECMRA was tackling the topic of recycling, the Association of Plastics Manufacturers in Europe (APME) was conducting a forum on the feedstock recycling technology being developed by a European consortium of plastics producers at a pilot plant in Grangemouth, Scotland. The consortium, consisting of BP Chemicals, DSM, Elf Atochem, EniChem, and Petrofina, is developing technology that uses a fluidized-bed thermal cracking process at relatively low pressures.

The pilot project, located on BP Chemicals' plant complex, is assessing the technology, as well as the operating costs and levels of investment required for its implementation. The consortium's objective is to take the technology up to the stage of conceptual design of a semicommercial demonstration plant, with capacity of 25,000 metric tons of mixed plastics waste per year. Total investment for such a plant is estimated at about $32 million. Following completion of the program, the results can be used or licensed by each member of the consortium.

Feedstock recycling, says Fred Mader, APME's deputy director, "will be able to increase total plastics waste recycling, but it must be developed as part of an integrated waste-management strategy."

*Patricia Layman*

# OTA Report Links Research And Technology To Economic Development

■ ***Study raises concerns that research funded by federal government may be aiding foreign companies that invest in the U.S.***

Investments in research and development by large multinational enterprises have a direct impact on the competitiveness and international trade of nations. A new study of this relationship by the Congressional Office of Technology Assessment (OTA) raises concerns about the imbalance of these investments between the U.S. and its trading partners. Some policy changes are suggested to correct the situation.

OTA finds that despite recent trends toward internationalization of technology, most multinational enterprises develop their core technology in their country of origin. U.S.-based corporations, for example, conduct less than 13% of their manufacturing R&D abroad, and what data are available for European and Japanese companies indicate that they may conduct even smaller percentages of their R&D abroad than do U.S. firms.

The OTA analysis, the final of two studies on this issue, was requested by Sen. John D. Rockefeller IV (D.-W.Va.), chairman of the Commerce, Science & Transportation Subcommittee on Science, Technology & Space and one of the authors of the failed technology competitiveness act of 1994 (S. 4). Rockefeller was seeking information that would help U.S. policymakers understand how highly developed countries invest in other countries and how that affects the U.S. economy.

"Congress must be sure that the technology programs supported by American taxpayers' dollars reap dividends for Americans—especially high-paying manufacturing jobs in the U.S.," Rockefeller said when releasing the report. "Examples of such programs include the National Institute of Standards & Technology's Advanced Technology Program in the Department of Commerce and the Defense Department's Technology Reinvestment Program."

*Rockefeller: U.S. taxpayers must benefit*

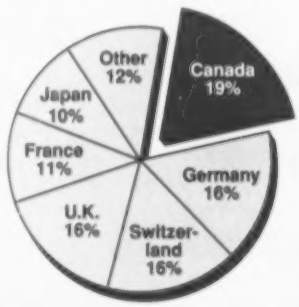
OTA suggests that Congress may wish to consider some sort of national benefit criteria to ensure that foreign-owned multinational companies that participate in these government-supported programs contribute directly to the U.S. technology base, not just indirectly through an affiliate. On average, OTA reports, such foreign-based companies contribute less to the U.S. technology base than do U.S.-based firms. However, establishing any such criteria would be difficult.

Foreign affiliate investment in R&D has increased substantially in recent years, from $4.5 billion in 1980 to $10.7 billion in 1992. More than half of the R&D spending was on manufacturing in three industries: chemicals, pharmaceuticals, and nonelectrical machinery. The most growth has been in pharmaceuticals. U.S. firms, on the other hand, increased their R&D investment in other nations from $4.3 billion to $8.4 billion during that same period. Principal manufacturing areas of concentration were machinery and transportation equipment. Usually this spending supports R&D by a company's own affiliates.

OTA reports that a factor significantly affecting the technology base is the tendency of Japanese firms to spend more on technology development as a percentage of their nation's gross domestic product than do their U.S. or European counterparts. Between 1981 and 1993, R&D expenditures by industries in Japan grew at an average rate of 8%. The average growth rate for U.S. firms was 3.9%. One reason cited for this difference is that the U.S. devotes much of its R&D budget to defense-related development, while other nations, especially Japan and Germany, are oriented more toward commercial technologies.

The report also analyzes other aspects of the U.S. trade deficit with Japan, a condition that's expected to continue for years to come. Part of the reason for the continuing deficit, says OTA, is that in-

**Canada leads foreign R&D investment in U.S.**




**1992 R&D expenditures in U.S. by foreign companies = $10.7 billion**

Source: Office of Technology Assessment

vestment in the U.S. by large Japanese multinational firms exceeded U.S. investment in Japan by a factor of three to one. OTA reports that while global foreign investment expanded dramatically in the 1980s and 1990s, U.S. direct investment in Japan failed to keep pace with the trend.

Among the reasons cited for this difference in investment is that long-term capital markets in Germany and Japan are more patient in waiting for a return on their investment. Also, the distinctive cross-shareholding and corporate banking relationships that shape business strategies in Japan and European nations are not as open to U.S. firms.

OTA identifies three policy strategies the U.S. might consider in responding to what it sees as international asymmetries in the global trade, investment, and other barriers to comparable market access. The first involves seeking to expand existing multilateral trade agreements to include issues such as direct foreign investment and restrictive business practices, some of which are included in the recent trade treaty negotiated by the General Agreement on Tariffs & Trade (GATT), which Congress will take up in late November.

Second, OTA concludes that the U.S. might adopt a two-tiered policy regime that grants equal footing to domestic companies and foreign affiliate companies when comparable market access exists, but that places conditions on equal treatment in response to enduring formal or informal market barriers in the company's home nation. Third, the U.S. could augment a broad multilateral strategy with domestic measures designed to improve U.S. technological capabilities and reform U.S. trade and investment policies to meet the demands of increasingly global commerce.

Rockefeller thought the U.S. was moving along the right path last year with his competitiveness legislation, but the bill got derailed in conference committee at the end of Congress this year. He also supports passage this year of the legislation needed to implement GATT, which would help remove trade barriers and open markets.

*David Hanson*

# NIH unit reorganizes research support programs

The National Institute of General Medical Sciences (NIGMS), the largest single source of chemistry funding within the National Institutes of Health, has reorganized to reflect the increasingly interdisciplinary nature of the research it supports. The changes are also meant to streamline its operations in accord with the Clinton Administration's push to reinvent government.

## Chemistry support is spread through three NIGMS divisions

Division of Cell Biology & Biophysics
- **Analytical and separation techniques**
- **Bioengineering**
- **Biomedical instrumentation**
- **Cell organization, motility, and division**
- **Lipid biochemistry**
- **Membrane structure and function**
- **Molecular biophysics**
- **Spectroscopic techniques**
- **Structural biology**

Division of Genetics & Developmental Biology
- **Cell growth and differentiation**
- **Chromosomal organization and mechanics**
- **Control of gene expression**
- **Developmental genetics and cell biology**
- **Extrachromosomal inheritance**
- **Human medical genetics**
- **Mechanisms of mutagenesis**
- **Molecular immunobiology**
- **Neurogenetics and the genetics of behavior**
- **Population genetics**
- **Replication, recombination, and repair of genes**

Division of Pharmacology, Physiology & Biological Chemistry
- **Anesthesiology**
- **Biochemistry**
- **Bioenergetics**
- **Bio-organic and bioinorganic chemistry**
- **Biotechnology**
- **Glycoconjugates**
- **Medicinal chemistry**
- **Pharmacology**
- **Physiology**
- **Synthetic chemistry**
- **Trauma and burn injury**

NIGMS's mission is much broader than those of the other NIH institutes, which specialize in specific diseases or organs. NIGMS, in contrast, supports the basic science underlying health-related research. The institute also leads NIH's activities aimed at increasing the number of minority scientists in biomedical research. NIGMS staff conducts no research itself, so the bulk of its budget—approximately $900 million for fiscal 1995—goes directly to universities and other research institutions.

In the most significant change, the institute has rearranged its four program branches—Cellular & Molecular Basis of Disease, Genetics, Biophysics & Physiological Sciences, and Pharmacology & Biorelated Chemistry—into three divisions: Cell Biology & Biophysics, Genetics & Developmental Biology, and Pharmacology, Physiology & Biological Chemistry. Also, the Minority Opportunities in Research programs have been designated a division.

"The reorganization reflects the increasingly interdisciplinary nature of the research funded by NIGMS," says Marvin Cassman, the institute's acting director. "By refining the distribution and balance of scientific areas among the divisions, we will improve the institute's ability to promote and support the most innovative basic research of the future."

The changes should not be noticeable to scientists supported by NIGMS, however. "We are not diminishing support for any field," says Warren Jones, chief of the biochemistry and biorelated branch in the new Division of Pharmacology, Physiology & Biological Chemistry. The reorganization is not meant to redirect the emphasis of NIGMS's grant portfolio, but to streamline its administration.

NIGMS, like other NIH units and the federal government in general, is faced with complying with the Clinton Administration's reinventing government goal of reducing work force rolls. The new structure is designed to help the institute administer an ever increasing number of grant applications with a slightly smaller staff.

NIGMS also has moved to the NIH campus in Bethesda, Md., from quarters in a rented building a few miles away. The entire institute staff is now located in the new William H. Natcher Building on the main campus.

*Pamela Zurer*